SHORT COMMUNICATION

AN OCCURRENCE OF "MOISSANITE" (SiC) FROM SEDDONVILLE, WEST COAST, NEW ZEALAND

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SUMMARY

Rodgers, K.A., Courtney, S.F., Seelye, R., McCulloch, B.A. & Mulholland, I. (1989). An occurrence of "moissanite" (SiC) from Seddonville, West Coast, New Zealand. *New Zealand Natural Sciences* 16: 105-108.

Well crystallized, polytype 6H silicon carbide ("moissanite") formed inside a wood-fired boiler's fire box at Seddonville during its use from 1917 to 1932. Appropriate silica-reducing reactions may have occurred in regions of incomplete combustion and involved siliceous soil embedded in bark and wood. Such a mechanism could permit SiC to form during firestorms accompanying forest fires; the refractory compound surviving chemical weathering to accumulate in fluviatile and lacustrine deposits.

KEYWORDS: Silicon carbide - moissanite - Seddonville - West Coast.

INTRODUCTION

The rare mineral moissanite has been reported from a wide range of igneous and sedimentary environments as well as meteorites (Moissan 1905, Regis & Sand 1958, Bauer *et al.* 1963, Addamiano 1975, Vigorova *et al.* 1978, Miyano *et al.* 1982, Bernatowicz *et al.* 1987). Doubts have been expressed about the authenticity of some, if not all of these reports (Yudin 1970, Mason 1983 in Fujii 1986). Milton & Vitalano (1985) describe natural silicon carbide as a "geological aberration", arguing that "not one report has satisfied any of several relatively simple criteria by means of which its natural existence could be substantiated, as opposed to carborundum contamination either in nature or during sample preparation".

In part these concerns arise from thermodynamic implications that extremely low oxygen fugacities are required for formation of the mineral. These conditions are unlikely to be met at shallow crustal depths (Marakushev & Genkin 1972 in Marshintsev *et al.* 1982). New evidence is starting to emerge however, which suggests that extreme conditions may not be essential (Fujii 1986). The find at Seddonville of a specimen of silicon carbide which had crystallized inside the fire box of a wood-fired boiler, indicates that the alpha-form of the compound is able to form under local, albeit specialized, conditions which are readily obtainable on and in the crust.

OCCURRENCE

Syd Marris operated a sawmill in Seddonville on the West Coast of the South Island (41° 33′S; 171° 59′E) from World War I through to about 1932. A clean-up of the plant in 1939 revealed a crystalline mass of silicon carbide in the back of

the firebox of the wood-fired boiler. While the mill was operating the boiler was fuelled with slabs of rimu (*Dacrydium cupressinium*) and kahikatea (*Podocarpus dacrydiodes*), including some heart timber. No coal is believed to have ever been used. The logs were dragged overland to the mill, and it seems likely that soil from the surrounding siliceous substrate became embedded in bark and cut wood surfaces. The silicon carbide specimen is presently in the possession of one of the authors (I.M.).

PROPERTIES AND COMPOSITION

The specimen measures approximately 170 x 75 mm (Fig. 1). Crystals range up to 11 mm across, and are pale blue-green, displaying the typical iridescent metallic lustre associated with surface oxidation of silicon carbide. Scanning electron microscope examination of three fragments showed numerous hexagonal tablets displaying a variety of forms and habits (Fig. 2). Crushed grains exhibit a very pale lemon yellow/lavender blue dichroism in immersion oil. Fracture is conchoidal, with several fragments showing a distinct cleavage.

The samples' specific gravities ranged from 2.997 to 3.146 g/cc, the variation presumably reflecting the presence of numerous pores and inclusions seen throughout the sample. The inclusions varied in composition but the main elements revealed by qualitative EDAX examination were K, Ca, Fe, Al, and Si. This is consistent with the common occurrence of these silicates in ash derived from New Zealand native hardwoods. The back of the specimen is coated with a thin ash layer.

The x-ray powder diffraction signature of one small, multicrystal fragment broken from the main mass conforms closely with that of SiC, polytype 6H (Thibault 1944).

DISCUSSION

There is little question that silicon carbide can form at temperatures below those generally used for its industrial preparation (c. 2100-2700°K). Schützenberger (1892) succeeded in synthesizing the compound at red heat from a silicon/silica mix in a graphite crucible packed with lamp black. Holliday *et al.* (1973) not only note that silicon carbide can form whenever siliceous and carbonaceous material are heated together to red heat or higher with carbon in excess, but that it can result from the ignition of organosilicon compounds in a stream of oxygen, or from igniting SiO_2 in a moist filter paper. Clearly, extremely low oxygen requirements, while desirable, are not essential for the compound's formation, and need at best be present on a microdomain scale only.

Carbonization of wood at 1500°K yields gas

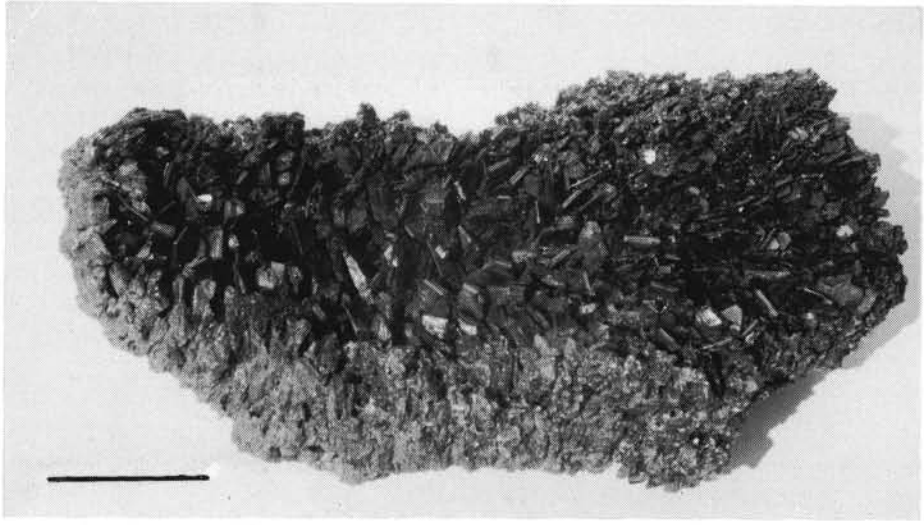

Figure 1. The Seddonville "moissanite" specimen. Scale bar = 30 mm.

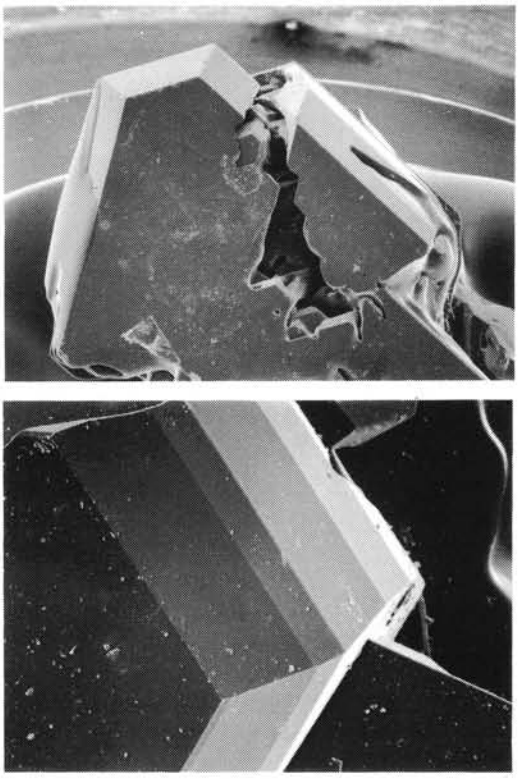

Figure 2. Scanning electron microphotographs of silicon carbide crystals from the Seddonville specimen. Relatively few forms have developed, in contrast to the crystal described by Thibault (1944). Upper: base of photo equals 4.5 mm; lower: base of photo equals 1 mm.

containing CO_2 (13%), C_nH_m (2%), CO (24%), H_2 (45%), CH_4 (15%) and N_2 (1%) (Steiner 1946). If imperfect combustion occurred in regions of the fire box, sufficient amounts of appropriate gases may have been able to accumulate there to facilitate reduction of silica to carbide via a mechanism similar to that in Schützenberger's (1892) experiment:

$$SiO_2 + CO \rightarrow SiO + CO_2$$
$$SiO + CO \rightarrow Si + CO_2$$
$$Si + 2CO \rightarrow SiC + CO_2$$

Whatever the precise details of the reaction mechanism, this occurrence points to a possible mode for formation of some natural moissanites which does not require the very deep crustal, highly reducing conditions invoked by numerous authors to account for the presence of silicon carbide in geological environments (Lyakhovich 1980, Marshintsev *et al.* 1982, Oleynikov *et al.* 1985). The conditions met in the firebox might well be replicated in firestorm cells during major forest fires, with small amounts of silicon carbide being produced above a silica-rich substrate. The refractory nature of the compound would assist in its survival during any subsequent chemical weathering, enabling it to become preserved in, for example, fluviatile deposits (cf. Kaminskiy *et al.* 1969).

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